PB-215 465

STUDIES OF BATHING WATER QUALITY AND HEALTH

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1952

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PB 215 465

Approx. 4000 words
Five Tables

*STUDIES OF BATHING WATER QUALITY AND HEALTH

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Introduction

In an attempt to determine the relationship between natural bathing water quality and its effect upon the health of the bather, a series of field studies were recently undertaken by the Environmental Health Center. The specific objectives of the studies were: to determine what frequency of swimming might be expected from the population groups chosen; to determine what relative increase in illness incidence might be expected from swimming in even the cleanest waters; and to determine what differences in illness incidence might be expected from swimming in waters containing various degrees of bacterial pollution.

The attainment of these objectives, even in part, was recognized at the beginning as a major task and after several years of work, many questions still remain unanswered.

Three studies of bathing waters and population groups in different geographical locations were designed so that factual data might be secured for the use of health administrators in determining what quality of bathing water would be acceptable to them in view of local conditions in individual states and areas. These studies illustrate the necessity for a cooperative approach in tackling environmental health problems. They represent the joint effort of epidemiologists, engineers, health educators, statisticians, and specialists in the physical and biological sciences working in harmony with health officers, other State and municipal officials, and the public.

It should be noted that in these studies consideration was not given to the less tangible, but none the less, beneficial aspects of outdoor swimming, such as fresh air, mental relaxation, moderate amounts of sunshine, physical exercise, etc.

The studies were conducted on (1) a great lake; (2) an inland river and a fresh water recirculating pool, and (3) a tidal water. Specifically, the locations were Lake Michigan at Chicago, Illinois; the Ohio River at Dayton, Kentucky, and a nearby swimming pool in the same area; and finally Long Island Sound at New Rochelle and Mamaroneck, New York.

General Methods

The general methods used were similar for the three studies although specific improvements in details were made with each succeeding project.

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*Presented before the Second Session of the Engineering Section of the American Public Health Association at the 80th Annual Meeting in Cleveland, Ohio, October 23, 1952.

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In each study, two bathing areas were selected on the basis of the following criteria:

(1) The beach waters had substantial differences in bacterial quality based upon historical records of water quality available. Unfortunately, subsequent laboratory examinations did not always show such differences.

(2) Sanitary surveys indicated that the water quality was not subject to rapid fluctuation, although changes over a period of days were desirable.

(3) The areas were in close proximity to resident population groups of 1500 or more families.

(4) The areas were used frequently for swimming by residents of the adjacent areas. Non-swimmers of the same age and sex and living in the same areas formed one of the control groups used. (Non-swimmers were persons who did no swimming during the course of the study).

In order to eliminate as many variable factors as possible, the population groups selected for each study were from similar socio-economic levels and from the same general geographic area.

After selection of the study areas, six major field activities were undertaken during the summer periods.

First, a public information campaign was undertaken with the assistance of local public health educators in the area. This campaign was aimed first at the entire community to acquaint it with the general purposes of the project, and secondly, and more intensively at the selected study areas, to focus on them the more detailed information on the project needs. The usual information methods were used including radio and television broadcasts, newspaper articles, distribution of flyers, and talks to local medical societies, PTA groups, and other civic bodies.

Second, project workers visited the families in the selected areas to secure their agreement to cooperate in the study. Cooperating families were furnished with a calendar record form to record swimming and illness experience daily and were instructed in how to fill it out. The diseases recorded on the basis of a familial diagnosis were eye, ear, nose, and throat ailments, gastro-intestinal disturbances and skin irritations.

Third, water quality determinations were made on samples collected from the selected beaches at intervals necessary to observe significant fluctuations. Associated with this, information on rainfall, temperature, wind, flow conditions, sanitary conditions, and other physical factors was obtained.

Fourth, bathing load observations were made at the time of sample collection for use as a general check.

Fifth, follow up visits to households participating in the study were made two or three times during the swimming season and associated with this the public information campaign was continued.

And sixth, at the end of the study period, each household was visited and as necessary revisited to insure final completion and pick-up of the calendar record forms.

It was interesting and encouraging to note that after being in possession of these forms for about two months, at the end of each study, participating families returned about 80% of them in usable form, although there was evidence that in some instances the calendar forms were not kept up on a day-to-day basis.

Upon completion of the field and laboratory aspects of the study, the major job of statistical analysis remained. The swimming and illness experience for each individual in the study was transferred to punch cards for machine tabulation. Statistical analysis of the results was then made by two or more of three methods.

(1) Observation of the prevalence and incidence of illness in each area as related to swimming experience and average water quality over the entire period.

(2) Selection of periods of significant poor bathing water quality and good quality, followed by analysis of swimming experience and illness incurred during these periods and for the days immediately succeeding them.

(3) Observation of the number of people having an onset of illness a specified number of days after swimming and the comparative water quality on the day when swimming occurred.

Individual Study Conditions

To be more specific, each study presented individual problems in the application of the general methods previously described. The conditions encountered in each study follow:

I - Great Lakes - Lake Michigan at Chicago, Illinois[1)]

The Chicago study was the first of its type to be undertaken. The bathing areas selected were immediately adjacent to residential areas comprising apartment buildings and individual houses in the middle and upper middle income brackets. The population groups were selected in the belief that most of the swimming done by residents would be at the selected beaches. This was borne out in the subsequent study. The two population groups comprised about 1600 families, or a total of 5124 individuals, fairly evenly divided between the two areas. The number of days of observation averaged 57.1 per person. A summary of the basic data for this and the subsequent studies is shown in Table 1.

(Insert Table 1)

It will be noted that the median water quality at the two beaches, expressed as coliform most probable number per 100 ml, was 91 at the North Beach and 190 at the South Beach. The maximum and minimum quality observed at any of the sampling points at the North Beach was 3500 and 9.1 respectively, and at the South Beach 24,000 and 23. Significant individual variations in water quality at the beaches were also taken into consideration in the analysis.

The total number of illnesses recorded in the study was 2237, fairly evenly divided between the two areas. Nose and throat ailments represented about half of the illnesses reported and gastro-intestinal disturbances almost one-fifth. The balance included eye and ear ailments, skin irritations, and various combinations of illnesses.

The over-all percentage of person-days on which swimming was done (hereafter referred to as person-days of swimming) for the two groups was in excess of 10 for each group, with the preponderance of it being done at the selected study beaches. There was no significant difference between males and females. As would be expected, individuals reporting one or more chronic ailments did somewhat less swimming, but even these groups swam 8 to 10 percent of the days of observation.

II - Inland River and Pool - Ohio River at Dayton, Kentucky, and Tacoma Park Pool[2)]

The second comparative study was made in northern Kentucky. A relatively poor quality water was selected in the Ohio River at Dayton Bar. No other convenient and regularly used bathing area was available on the Ohio River. Hence, it was decided to use Tacoma Park Pool, a recirculating fresh water pool located in Dayton, Kentucky, as the second bathing area for comparative purposes.

The median water quality at Dayton Bar was 2700 coliform organisms expressed as most probable number per 100 ml. The maximum and minimum coliform densities were 160,000 and 230 respectively. On the other hand, the Tacoma Park Pool water generally showed no gas production in the 10 ml portions or a most probable number of coliforms of less than 3.0. The residual chlorine level in the pool was maintained at 0.1 ppm to 0.75 ppm during most of the study period. On a few occasions residuals of less than 0.1 were noted and for the last five days of the study, residuals of 1 to 2 ppm were maintained.

Diving facilities were available at the pool but not at the river beach.

The population group used included 7520 individuals mostly residents of Dayton and Bellevue, Kentucky. In this study, there was no particular geographical separation between "river" and "pool" swimmers in contrast to the marked separation between the two beach groups in the Chicago study. The Kentucky study group represented middle income families dwelling, for the most part, in single family houses.

A poliomyelitis outbreak in northern Kentucky during the summer effectively reduced the frequency of swimming to the near vanishing point late in July, which resulted in limiting the length of the study. The number of days of observation averaged 32.2 per person for the abbreviated study period. The basic data is summarized in Table 1. It should be noted also that the swimming experience observed was divided roughly into 1/3 in the river, 1/3 in the pool, and 1/3 at other

swimming areas. The total number of illnesses of all types recorded was 2130. The rate of 8.8 per 1000 person-days was somewhat more than was observed in Chicago.

III - Tidal Waters - Long Island Sound at New Rochelle and Mamaroneck, N.Y.[3)]

The third comparative study was made in tidal waters off Westchester County, New York. Municipal beaches on Long Island Sound located at New Rochelle and Mamaroneck, respectively, were chosen. Adjacent population groups in the two communities were selected in residential areas of the middle and upper middle income groups.

The median water quality at the two beaches measured as most probable number of coliforms per 100 ml was 610 at New Rochelle and 253 at Mamaroneck. The maximum and minimum coliform levels determined for both beaches were <30 and 460,000, respectively. The tidal factor entered into this study. At New Rochelle, the coliform densities were somewhat higher during flood than during ebb tide, with poorest quality generally occurring during the first half of the flood tide. It should also be noted that poorest water quality generally followed storms and the operation of storm overflow sewers, but bathing was less frequent during these periods.

The New Rochelle population group numbered 4590 individuals, the Mamaroneck group 4930. The number of days of observation averaged 60 per person. As is shown in Table 1, the percentage of person-days of total swimming reported by the two groups is considerably more than was recorded in Kentucky but less than that noted in Chicago. However, more than one-fourth of this swimming was done at locations other than the study beaches.

The total number of illnesses of all types was 3300 for the two groups. At New Rochelle, this represented 5.3 per 1000 person-days and at Mamaroneck 6.2, the lowest rates observed in any of the three surveys.

Results

The over-all comparative data for the three studies have been summarized in Table 1. However, the most significant results are obtained by more selective analysis and observation of smaller groups and wider ranges of water quality.

With respect to the first specific objective of the studies, the swimming experience of various groups at the bathing areas under study is shown in Table 2. The percentage of total person-days of swimming is given for males and females with and without reported chronic conditions and subdivided into age groups. From this table, it is apparent that there was no appreciable difference in the amount of swimming done by males and females of all ages at the Chicago beaches or in Tacoma Park Pool. The males showed a higher tendency to swim in the Ohio River and the females to use the Westchester County beaches. Surprisingly, the amount of swimming done by persons reporting one or more chronic conditions approached and in some cases exceeded that done by individuals reporting no chronic conditions. However, most of the chronic conditions noted were of a minor nature, allergies being particularly prominent.

(Insert Table 2)

In almost every instance, the greatest amount of swimming was done by persons in the 10 to 19 year age group. For the three studies, the greatest amount was done by males at the South Beach in Chicago, where they averaged swimming every third day during the study season for the entire group, including swimmers and non-swimmers. The second largest amount of swimming was done by persons in the 5 to 9 year age group and closely approached the amount of the older children.

In Chicago and in Westchester County the youngest children, under 5 years of age, exceeded the amount of swimming done by adults in the 20 to 44 year age group by more than 50%. The youngest children averaged a trip to the beach once every 6 to 18 days. However, at Tacoma Park Pool and the Ohio River, very little bathing was recorded for the "under 5 year old" group.

As would be expected, the age groups over 44 years of age did the least amount of swimming.

The total amount of swimming at the individual bathing areas varied in accordance with its accessibility from the residence area, size of population group, availability of other swimming areas, cost, attractiveness of bathing area, and weather. The swimming experience at the designated areas was greatest at Chicago, roughly half as much in Westchester County, and only about 15% as great in Tacoma Park Pool and the Ohio River.

The respective over-all illness incidence rates per 1000 person-days among non-swimmers at each of the bathing areas were:

North Beach, Chicago	3.7
South Beach, Chicago	5.6
Dayton-Bellevue	7.4
New Rochelle	3.3
Mamaroneck	3.3

An approximation of the relative increase in illness incidence from swimming in relatively clean waters listed as the second specific objective is shown in Table 3. The ratio of illness incidence is given for Chicago groups doing different amounts of swimming over the entire period as compared with that for non-swimmers. In developing this table, age-specific illness rates were applied to the various age groups in each category. The rates for all ages were then adjusted to take into account differences in age distribution of the populations in the sub-groups. In this crude comparison, no significant correlation was observed which could be attributed to swimming in natural waters of different quality at the areas studied. However, in practically every instance the illness incidence among swimmers was higher than that among the non-swimmers. This was expected inasmuch as water is an abnormal habitat for man regardless of its bacterial quality. The illness incidence increased for progressively higher swimming frequencies, but the groups doing the most swimming tended to show less rise in illness incidence and in several instances a marked decrease. This may well be explained by the selective physical characteristics of individuals in the group which did the most swimming, since illness occurrence would prevent their inclusion in such a group. The ratios shown for the Great Lakes studies may be affected by the

higher illness incidence observed among the non-swimming South Beach group as compared with its northern counterpart.

(Insert Table 3)

The highest actual over-all incidence of illness of all types observed among the natural bathing water swimming groups, was 13.4 per 1000 person-days (not shown in the tables) for South Beach swimmers who swam more than 24 days. Pool swimmers at Dayton, Kentucky, on the other hand, showed a much higher rise in over-all illness incidence, which reached 32 per 1000 person-days for the group which swam 10-19 days. As will be shown in Table 4, this is due primarily to a higher incidence of eye, ear, nose, and throat ailments in this group which may be attributed to "diving" and bathing in closer proximity to one another in a body of water with a lower dilution factor.

In Table 4, over-all illness incidence rates are shown for various groups as related to gastro-intestinal disturbances; eye, ear, nose and throat ailments; and other illnesses reported. In the Chicago and Westchester County areas there was about twice as much illness of all types reported for the groups under 10 years of age as for those 10 years of age and over. For all the studies the incidence of gastro-intestinal disturbances reported for the entire groups was less than 20 percent of the incidence for all types of illness; that for eye, ear, nose, and throat ailments was somewhat more than half of the total.

With respect to specific swimming groups, it is significant to note that the pool swimmers had an incidence for all types of illness of 13.8 per 1000 person-days. Eye, ear, nose, and throat ailments comprised 68 percent of this incidence; gastro-intestinal disturbances, 15 percent; and other illnesses, the balance. River swimmers in the same population group under study, on the other hand, showed a lower total illness incidence rate with gastro-intestinal disturbances representing 24 percent of the total, and eye, ear, and respiratory ailments, only 53 percent. These observations were given further analysis as will be shown later.

(Insert Table 4)

In the attempt to meet the third specific objective, namely, "to determine what differences in illness incidence might be expected from swimming in waters containing various degrees of bacterial pollution," an inspection of over-all illness incidence rates for the swimming groups was not fruitful and a more selective study was indicated. Consequently, days of relatively "high" and relatively "low" coliform densities were selected and analysis was made of the illness occurring among the swimmers on these days.

In Table 5 the illness incidence rates are shown for the week following swimming on selected days of relatively "high" and "low" coliform densities in the Great Lakes Study. The observed three-day incidence rate of 12.2 per 100 South Beach swimmers for illnesses occurring within a week subsequent to swimming is significant. It indicates that swimming in these waters containing a logarithmic average coliform density of 2300 per 100 ml may cause more illness than swimming in waters with the lower average densities shown. However, as will be shown, this finding was not borne out by the results of similar comparisons in other studies.

In the Ohio River and Tidal Water Studies, analysis was made of the over-all illness incidence one, two, and three days following swimming in waters of significantly different bacterial quality. The ranges of water quality for the Ohio River Study were: less than 1400, 1400 to 3900, and greater than 3900 coliform MPN per 100 ml, respectively. However, the number of swimmers on the selected days was small and did not permit a sensitive comparison to be made. No significant difference was observed between incidence of illnesses of all types following swimming on days of "greatest" pollution and "least" pollution. At Long Island Sound comparisons were made between illness incidences among swimmers in waters with coliform density of less than 190, 190 to 430, 430 to 1250, and more than 1250. Here also, no significant difference was observed in the illness incidence rates among swimmers in the waters of different quality. It is interesting to note that the illness incidence among non-swimmers on the identical days reported for the swimming group in the latter study, was only one-third to one-half of that shown for the swimmers.

(Insert Table 5)

In comparing the Ohio River Study data related to gastro-intestinal disturbances, a second positive correlation was observed between bathing water quality and health. Although the comparative incidence of illnesses of all types was higher for pool swimmers than for river swimmers, an analysis of specific types of illness gives a different picture. Illness rates for all swimming groups combined, but specific for age and amount of swimming, were used to compute "expected" illnesses and to compare them with "observed" illnesses. This comparison showed that river swimmers had 32 percent more gastro-intestinal illness than might be expected on the basis of the experience of all groups combined.

Consistent as this may be with the hypothesis of more gastro-intestinal illness for persons swimming in water with higher coliform densities, in this case 2700 per 100 ml, the result must be treated with great caution because of the small number of cases involved. It roughly corresponds to a probability of 5 percent that such a result could occur as an effect of chance. In any event, this observation cannot be explained away by a tendency of river swimmers to be less healthy in view of their relatively low over-all illness incidence.

Summary and Conclusions

The three studies have furnished valuable information on the swimming experience of individuals in various age groups and localities. They have demonstrated that an appreciably higher over-all illness incidence may be expected in the swimming group over that in the non-swimming group regardless of the bathing water quality. They have shown some 100 percent higher illness incidence in the group under 10 years of age than for those over 10 years of age. They have shown that in studies of this type, eye, ear, nose, and throat ailments may be expected to represent more than half of the over-all illness incidence, gastro-intestinal disturbances up to one fifth, and skin irritations and other illnesses the balance.

Specific correlation between illness incidence and bathing in waters of a particular bacterial quality were observed in two instances. First in the Chicago Study, a comparison was made between swimmers on days when the bathing water quality was relatively "good" or "poor". A significant increase in illness incidence was observed among swimmers who used the South Beach on three selected days when the water had an average coliform content of 2300 per 100 ml. The observation, based upon a significance test against the hypothesis that "high" pollution causes an increase in illness incidence, is one which could occur as a result of chance but once in one-hundred trials. This evidence should not be taken as conclusive, however. There were only three days on each side of the comparison and this did not permit a complete analysis of the effect that weather might have had on the result. But, it does provide a warning signal.

The second instance of positive correlation was observed in the Ohio River Study where it was shown that, despite the relatively low incidence of gastro-intestinal disturbances, river swimming in water having a median coliform density of 2700 per 100 ml appears to have caused a significant increase in such illnesses among these swimmers. Incidentally, the gastro-intestinal illness rate for this group was substantially higher than that observed for any other group in any of the three studies.

Admitting the difficulties of conducting studies in which nature rather than man controls many of the variables, sufficient evidence is available to indicate that some of the strictest bacterial quality requirements for natural bathing water now existent might be relaxed without significant detrimental effect on the health of the bathers. This always has been and will continue to be a matter of judgment. It is hoped that the results of these studies will aid the administrators responsible for making these decisions.

Acknowledgment

The helpful suggestions and comments on this paper made by Theodore D. Woolsey, Biostatistician, and Russell S. Smith, Engineer, are very much appreciated.

References

1) Smith, R. S.; Woolsey, T. D.; Stevenson, A. H. - Bathing Water Quality and Health - I Great Lakes 1951. Public Health Service, Environmental Health Center, Cincinnati, Ohio.

2) Smith, R. S. and Woolsey, T. D. Bathing Water Quality and Health - II Inland River and Pool 1951. Public Health Service, Environmental Health Center, Cincinnati, Ohio. (in press)

3) Bathing Water Quality and Health - III Tidal Water (in preparation)

Table 1

BASIC DATA SUMMARY

Study	Group	Median Water Quality at Study Bathing Area - Coliform MPN per 100 ml	Number of Persons in Study	Number of Person-Days of Usable Record	Percentage of Person-Days of Total Swimming	Number of Illnesses of all Types Recorded per 1000 person-days
Great Lakes	Chicago-North Chicago-South	91 190	5124	154,453 138,158	10.3 10.7	7.1 8.3
Inland River and Pool	Dayton and Bellevue	2700[1]	7520	242,094	4.5	8.8
Tidal Water	New Rochelle Mamaroneck	610 253	9520	269,629 300,503	7.3 8.0	5.3 6.2

[1] Ohio River at Dayton Bar. Pool water quality less than 3.0.

Table 2

PERCENTAGE OF TOTAL PERSON-DAYS WITH REPORTED SWIMMING AT DESIGNATED STUDY AREAS BY AGE GROUPS

Age Group	Great Lakes				Inland River[1] and Pool				Tidal Water[2]			
	North Beach		South Beach		River Pool				New Rochelle		Mamaroneck	
	Males	Females	Males	Females	M	F	M	F	Male	Female	Male	Female
Persons with no chronic conditions												
Under 5 years	15.8	17.0	13.3	12.7	0.8	0.8	0.5	0.4	5.5	6.4	6.2	8.3
5-9 years	25.6	25.2	23.2	22.9	1.5	2.1	2.2	2.0	8.5	8.6	14.0	13.5
10-19 years	28.6	27.7	32.9	25.8	3.9	2.0	4.6	3.9	10.0	11.2	11.4	15.7
20-44 years	6.4	9.1	8.1	9.0	2.1	1.0	0.6	0.9	2.3	3.6	2.9	5.3
45-64 years	4.3	3.6	3.3	1.6	0.8	0.3	0.1	0.2	2.6	1.9	1.2	2.8
over 64 years	0.4*	0.0*	0.7	0.1*	0.2*	-	-	-	0.8	2.2	0.9	0.8
Age unknown	1.7	2.2	8.1	8.9	5.4	0.6*	6.2	12.1	3.6	4.0	1.6*	9.6
All ages	10.5	10.9	11.1	10.5	2.0	1.2	1.5	1.5	4.5	5.4	5.3	7.4
Persons with one or more chronic conditions												
Under 5 years	15.2	21.8	2.1	30.8	0.4*	0.2*	0.2*	0.5*	2.3	3.0*	8.0	6.6
5-9 years	19.1	9.0	31.9	21.2	0.3*	0.8*	2.4	1.7*	10.8	5.6	15.3	17.9
10-19 years	23.5	23.0	34.0	26.8	3.1	1.0*	4.0	7.1	11.1	6.7	12.9	26.0
20-44 years	6.0	7.6	6.4	8.3	1.5	1.1	1.3	0.7	1.6	4.1	3.3	5.3
45-64 years	1.9	1.6	3.7	4.1	1.5	-	0.5*	0.1*	0.6*	1.2	1.7	6.4
over 64 years	-	-	0.4*	-	-	-	-	-	0.7*	1.0*	-	-
Age unknown	16.3	5.3	-	-	...	...	...	...	...	2.2*	-	...
All ages	8.7	8.0	9.9	9.7	1.6	0.8	1.5	1.2	3.7	3.6	5.6	7.7

1) Approximately an equal amount of additional swimming was done by the study group in non-study areas.

2) Approximately 50% additional swimming was done by the study group in non-study areas.

\- Numerator is zero

... Denominator is zero

* Based on less than 10 in the numerator

0.0 Less than 0.05

Table 3

RATIO OF ILLNESS INCIDENCE OF SWIMMERS TO NON-SWIMMERS
BY ILLNESS TYPE, SWIMMING FREQUENCY, WATER QUALITY, AND AREA
Great Lakes Study - Chicago, Illinois

Group	Median Water Quality Coliform Organisms MPN per 100 ml	Swimming Experience - Days			
		0	1 to 9	10 to 24	over 24
			All Types of Illness		
North Beach	91	1.0	2.2	2.3	2.6
South Beach	190	1.0	1.4	1.5	1.2
			Nose and Throat Ailments		
North Beach	91	1.0	2.2	2.5	2.4
South Beach	190	1.0	1.4	1.3	1.2
			Gastro-intestinal Disturbances		
North Beach	91	1.0	1.7	1.8	2.5
South Beach	190	1.0	0.9	1.0	0.7
			Other Types of Illness		
North Beach	91	1.0	2.4	2.4	3.1
South Beach	190	1.0	2.2	2.6	2.0

Table 4

OVER-ALL ILLNESS INCIDENCE RATES PER 1000 PERSON-DAYS

Study	Group	Types of Illness				
		All Types	Gastro-Intestinal	Other Illnesses Reported		
				Nose & Throat	Skin	Eye, ear and other
Great Lakes	North Beach.					
	Under 10 yrs.	13.1	2.3	7.0	1.4	2.4
	10 yrs. and over	5.9	1.2	3.2	0.5	0.9
	All Ages	7.1	1.4	3.9	0.6	1.2
	South Beach					
	Under 10 yrs.	12.7	2.0	6.4	1.4	2.0
	10 yrs. and over	7.1	1.4	3.8	0.5	1.5
	All Ages	8.3	1.5	4.3	0.7	1.8

Study	Group	All Types	Gastro-Intestinal	Other Illnesses Reported	
				Eye, Ear, Nose & Throat	Other
Inland River and Pool	Entire group-all ages	8.8	1.7	5.3	1.8
	*Non-Swimmers	7.4	1.5	4.4	1.5
	*Pool Swimmers	13.8	2.1	9.4	2.3
	*River Swimmers	10.1	2.4	5.4	2.3
	*Total Pool & River Swimmers	12.1	2.3	7.5	2.3

Study	Group	All Types	Gastro-Intestinal	Other Illnesses Reported	
				Eye, Ear, Nose & Throat	Other
Tidal Water	New Rochelle				
	Under 10 yrs.	8.0	1.1	4.1	2.8
	10 yrs. and over	4.3	0.6	2.6	1.1
	All Ages	5.3	0.8	3.0	1.5
	Mamaroneck				
	Under 10 yrs.	10.7	1.3	6.2	3.2
	10 yrs. and over	5.0	0.7	3.0	1.3
	All Ages	6.2	0.9	3.7	1.7

*Under 65 years of age

Table 5

ILLNESS INCIDENCE RATES FOLLOWING SWIMMING ON SELECTED DAYS OF SIGNIFICANTLY HIGH AND LOW COLIFORM DENSITY DURING GREAT LAKES STUDY

Groups	Number of Selected Days	1) Mean Coliform Density on Selected Days MPN per 100 ml	Number of Persons Swimming at Neighborhood Beach	Number of Swimmers Reporting Illness In Subsequent Week	3-day Illness Incidence Rate per 100 Swimmers
North Beach Swimmers	3 "high"	730	558	55	9.9
North Beach Swimmers	3 "low"	31	832	72	8.7
South Beach Swimmers	3 "high"	2300	566	69	12.2
South Beach Swimmers	3 "low"	43	932	79	8.5

1) Logarithmic average of results of all bacterial examinations.